Thesis Topics

(Some of these topics are described in more detail on the following pages.)

- Study of antenna performance on unmanned air vehicles (UAVs)
  > Antenna location and interference evaluation
  > Shared apertures
- Radar cross section (RCS) code development
- Phased array mutual coupling compensation techniques
  > Add on methods like "dummy" elements
  > Hardware design for mutual coupling cancellation and compensation methods
  > Simulation of compensation methods
- Array antenna code development
- Microwave powered micro-air vehicle (MAVs)
  > Antenna design
  > Rectifying circuit design
- Radar cross section (RCS) of buried targets
- Direction finding (DF) antenna development
- Phased array architectures based on off the shelf wireless technologies: (design, simulate, build)
  > Transmit channel architectures
  > Receive channel architectures
- Urban and indoor propagation study for wireless and UAV applications
  > WLAN modeling
  > Point-to-point wireless links
- Random arrays for bistatic hitchhiker radars
- Radar cross section of tunnel and cave openings
- Antennas for ground penetrating radar
- Radar glint models and multipath

Prof. Jenn S-414 (831) 656-2254 email: jenn@nps.navy.mil
home page: web.nps.navy.mil/~jenn/

General Study of Antenna Performance on Unmanned Air Vehicles (UAVs)

Northrop-Grumman-Ryan vertical takeoff UAV

Background: Unmanned air vehicles (UAVs) can be launched and recovered on both land and sea. It potentially can carry a variety of sensors and data links for surveillance and even some weapons systems.

Objective: Determine communications antenna performance as a function of location on the vehicle. Provide some general guidelines for antenna placement. Examine how antennas operating in different frequency bands might interfere with each other.

Task:* (1) Simulate antenna performance at various locations on the vehicle using a computational electromagnetics codes available in the Microwave and Antenna Lab. (2) Investigate shared aperture techniques (multiband or broadband antennas) so that several systems can use the same array.

Requirements: Antenna course

* two separate theses

Urban Propagation Issues for UAV Data Links

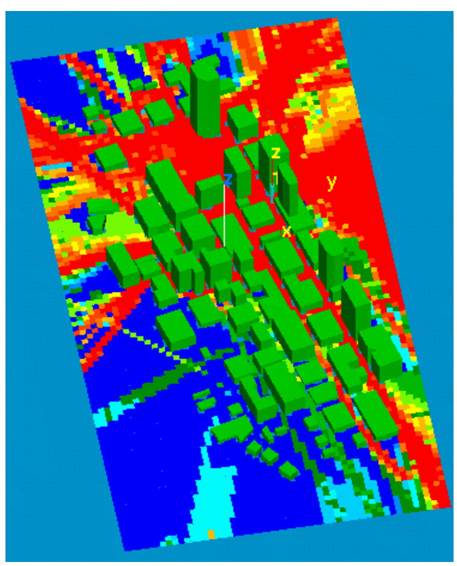
Background: UAV command, control and data links experience a unique propagation environment when operating in urban areas. Severe multi-path can result in a complete loss of command signals, which can limit the operational area or even cause a loss of the vehicle.

Objective: Examine several urban propagation environments using the code URBANA. Determine how the propagation environment affects the command, control and communication links from the ground to the UAV.

Task: Become familiar with the software package URBANA and build models of the selected problems. Generate received signal contours as a function of location and frequency.

Requirements: Antennas and propagation

Model of urban area and computed power contours



Broadband Antennas for Land Mine Detection

Background: Ground penetrating radar is used for the detection of unexploded ordinance. The antenna design is crucial. It must operate over extremely wide bandwidths and close to the ground (i.e., near-field operation as opposed to the conventional far-field operation)
Objective: Design and build a prototype broadband contra-wound spiral antenna. Other types of antennas may also be studied.
Task: Design and simulate the antenna using a software package. Build a prototype and take measurements.
Requirements: Antenna course

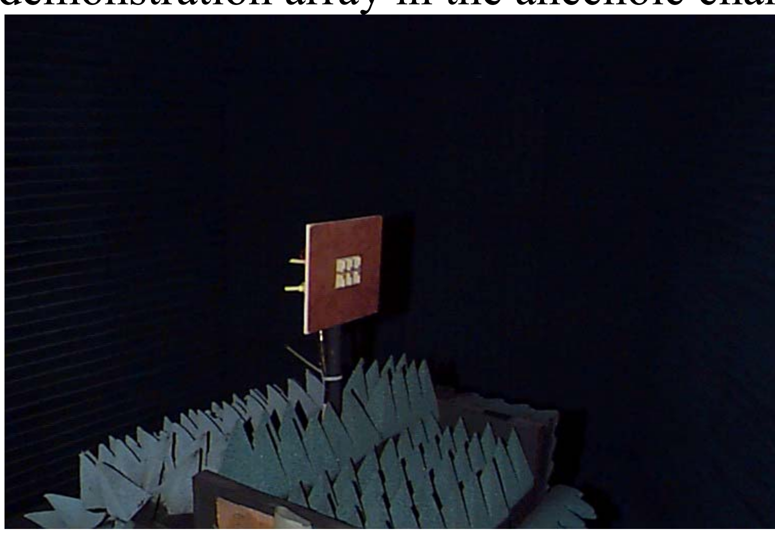
Mine detection radar in operation

Direction Finding (DF) Antenna Development

(with Prof. Pace)

Background: Direction finders are crucial for signal interception and identification. Very wide frequency bandwidths, wide fields of view, and high resolution are desired from electrically small antennas. This is especially challenging for low frequencies.
Objective: Look at using commercially available off the shelf wireless chips for *I* and *Q* direct down conversion.
Task: Study several commercially available wireless receiver chips that might be used to construct a "digital beamformer" for the RSNS array. Build a breadboard receiver and take measurements using the vector network analyzer in the Microwave Lab. The full array will be tested in the NPS anechoic chamber.
Requirements: Electronics and circuits, antenna course helpful

DF demonstration array in the anechoic chamber



Phased Array Mutual Coupling Compensation

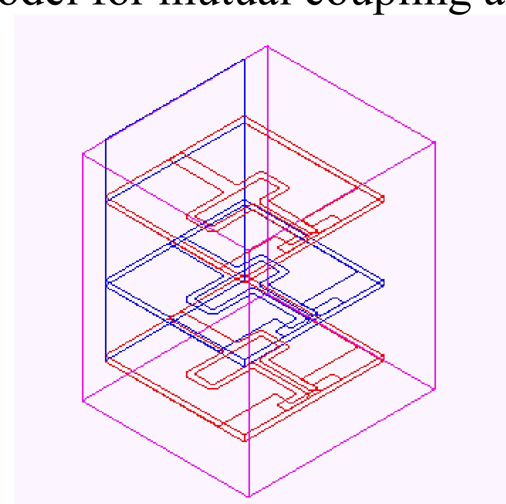
Background: For small arrays, mutual coupling variations from element to element are a source of amplitude and phase errors. This is an especially important problem for direction finding antennas, where the array elements essentially sample the incident wave front to estimate the angle of arrival.

Objective: Investigate several methods of mutual coupling compensation for phased arrays.

Task: Two projects: (1) Model several types of mutual coupling compensation circuits using the HFSS or Microwave Studio software. Promising designs will be fabricated and tested in the anechoic chamber. (2) Derive a scattering matrix model of the antenna and feed network, program it in Matlab and simulate several mutual coupling compensation networks.

Requirements: Antenna course

HFSS model for mutual coupling analysis



Vulnerability of Wireless Systems to Interception

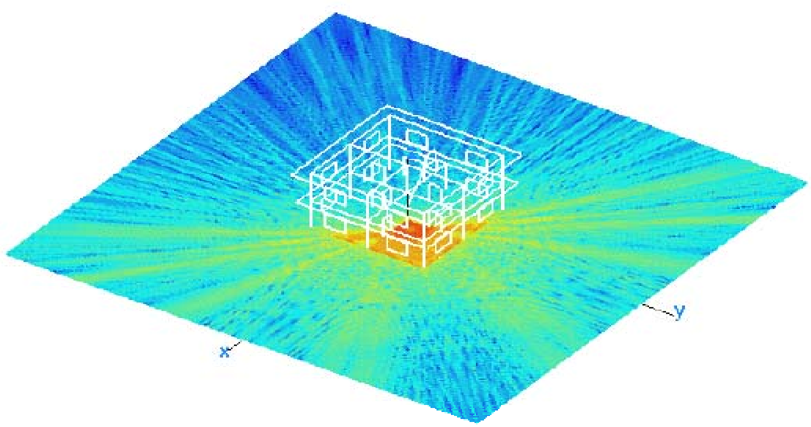
Background: Wireless systems are susceptible to interception in urban and indoor environments. The placement of base station antennas is usually determined by an experimental or analytical assessment of the propagation path. Analytical approaches are preferred because they are quicker and less costly.

Objective: Examine several urban and indoor propagation environments using the code URBANA. Candidate problems include: (1) ship spaces, (2) business campuses such as the NPS quad and surrounding buildings, (3) multi-point wireless distribution links in high-rise areas.

Task: Become familiar with the software package URBANA and build models of the selected problems. Generate received signal contours as a function of location and frequency.

Requirements: Antennas and propagation

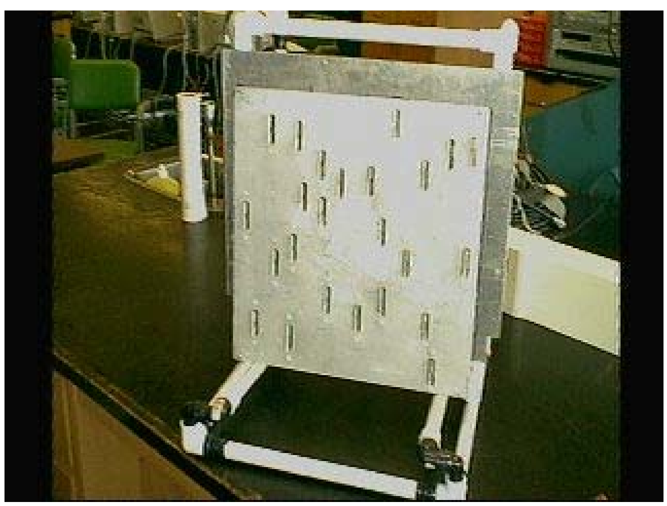
Indoor-to-outdoor propagation



Distributed Random Arrays for Bistatic Radar

Background: Array elements for a bistatic radar are distributed randomly over large areas randomly for: elements can be placed whereeever convenient, large areas can be covered to get high gain and narrow beams, and it is covert and survivable. Array excitations are determined using a genetic algorithm (GA) that has already been developed. A demonstration array was designed and built to verify the GA design
Task: Two separate projects: (1) build and measure a digital receive array, and (2) investigate methods to accurately measure element locations.
Requirements: Antenna course

Bistatic array antenna



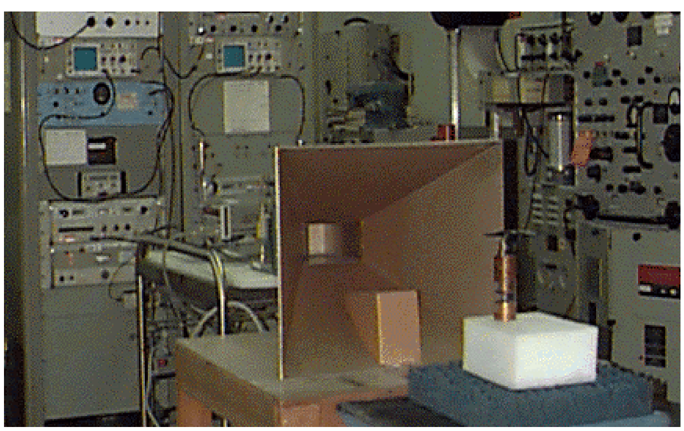
Microwave Powered Micro-Air Vehicles (MAVs)

<u>Background</u>: Remotely piloted vehicles have many military and civilian applications. Very small MAVs (several inches in size) have limitations on weight and volume, so the flight duration of battery powered vehicles is very short. It is possible to beam microwave power to the MAV from a ground station, giving unlimited duration at the expenses of short range. This thesis will be an extension of previous work that demonstrated microwave beaming for MAV propulsion.

<u>Requirements</u>: EC2610 or EO2652 (circuits and transmission lines)

<u>Tasks</u>: Review the previous work on wireless power transmission for small MAVs. Investigate new compact and efficient circuits for rectifying the received power. Design, fabricate and test the circuit in the Microwave Lab. Estimate the efficiency. Incorporate the circuit into a demonstration model.

MAV demonstration



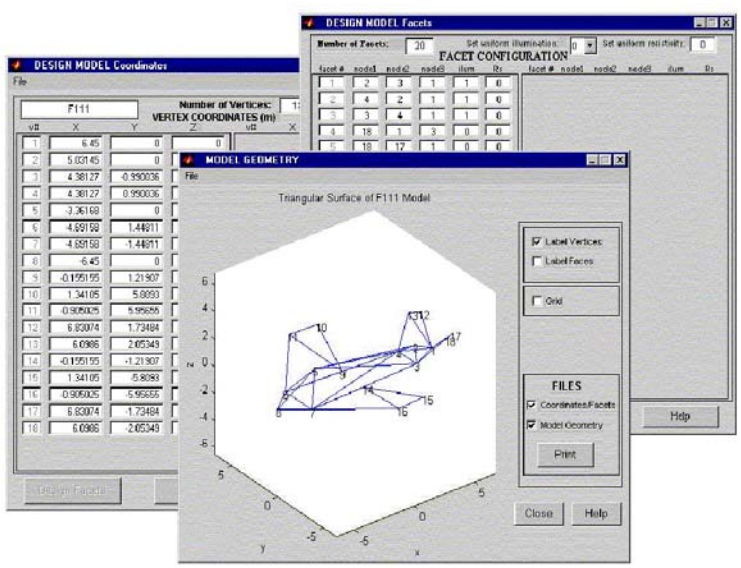
Development of Radar Cross Section Prediction Software

<u>Background</u>: Previous theses have contributed to the development of radar cross section (RCS) prediction software based on the physical optics approximation. The software has been distributed free of charge and is used by several contractors and universities.

<u>Task</u>: The objective is to add further capabilities to the software. The highest priority is the addition of infinite ground planes. This will allow the modeling of ships over the ocean and other objects over ground planes. The software is written in Matlab.

<u>Requirements</u>: Antennas helpful. Knowledge of Matlab.

POFACETS program GUI



Radar Glint Models and Multipath

<u>Background</u>: Radar targets such as aircraft have many scattering sources that interact in a complex manner. A radar tracks the "centroid" of the target; that is, a point at which the composite scattering center appears to be located. The centroid is not necessarily at the physical center of the target, and may in fact be somewhere off of the target. The result is unacceptable range and angle errors (i.e., inaccurate tracking). A similar problem occurs with the ground bounce. The radar tracks the centroid of the target return plus ground return, yielding very large tracking error.

<u>Task</u>: The objective is to study several glint models and compare the results. A complex "point scatter target" will be modeled in Matlab, and the results compared to theory. The approach will also be applied to ground bounce multipath and its effects on radar tracking examined.

<u>Requirements</u>: Antennas and radar helpful. Knowledge of Matlab recommended.

Ground bounce ECM